

# Phase Diagrams for Ceramists

**BEST AVAILABLE COPY**

Ernest M. Levin,  
Carl R. Robbins and -  
Howard F. McMurdie

Compiled at the National Bureau of Standards

Margie K. Reser, *Editor*

**FIFTH PRINTING 1985**

© Copyright, 1964, by  
The American Ceramic Society  
65 Ceramic Drive, Columbus, Ohio 43214

Printed in U.S.A.

ISBN 0-916094-04-9

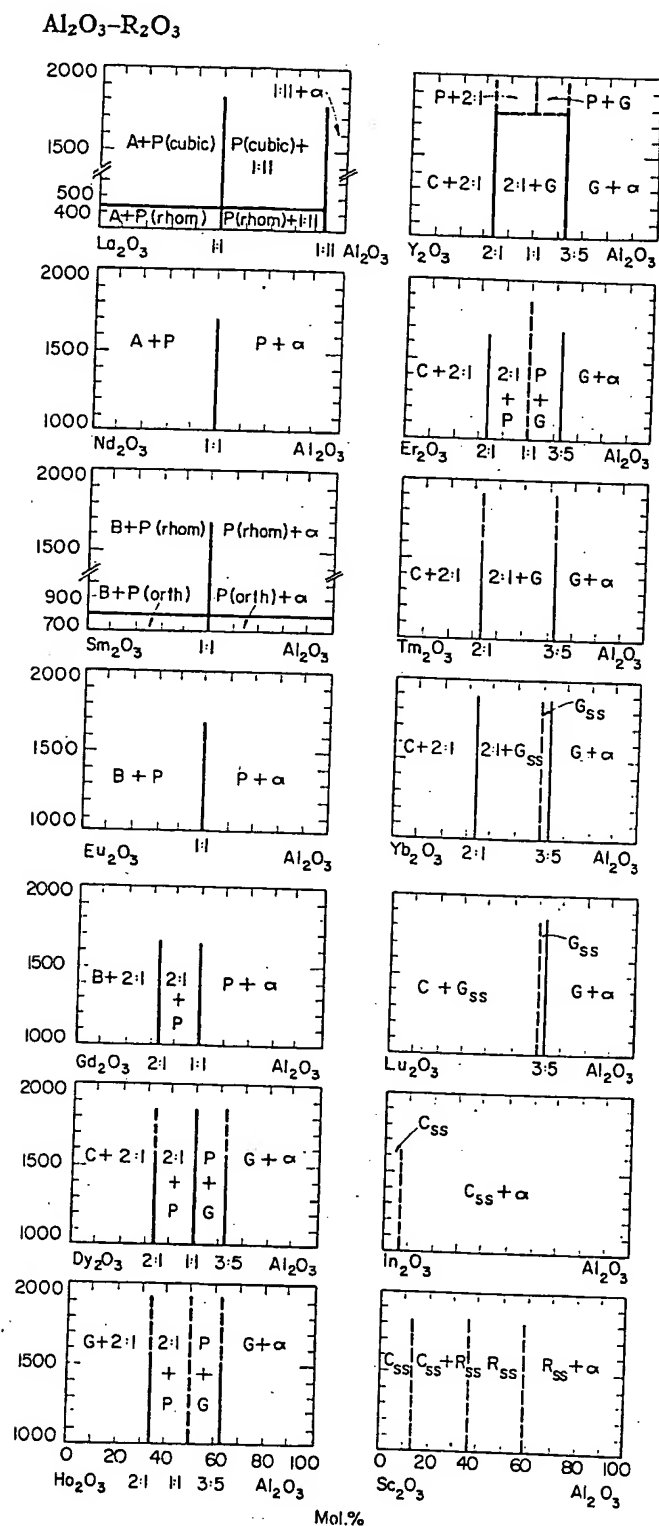


FIG. 312.—System Al<sub>2</sub>O<sub>3</sub>-R<sub>2</sub>O<sub>3</sub>; predicted subsolidus. Structure types: A, A-type rare earth oxide; B, B-type rare earth oxide; C, C-type rare earth oxide; G, garnet; 1:11, beta alumina; P, perovskite; R, unknown, rhombohedral symmetry; α, corundum.

S. J. Schneider, R. S. Roth, and J. L. Waring, *J. Research Natl. Bur. Standards*, 65A [4] 364 (1961).

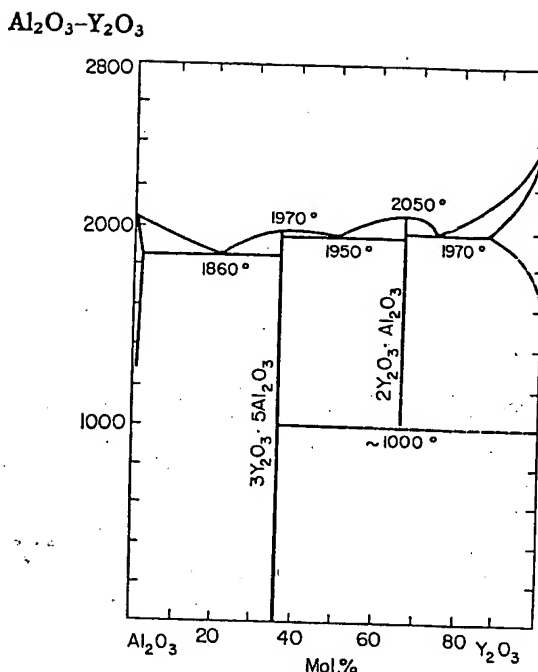


FIG. 311.—System Al<sub>2</sub>O<sub>3</sub>-Y<sub>2</sub>O<sub>3</sub>.

L. E. Olds and H. E. Otto, private communication, Dec. 27, 1961. Fig. 312 indicates additional 1:1 compound; see also, I. Warshaw and Rustum Roy, *J. Am. Ceram. Soc.*, 42 [9] 435 (1959).

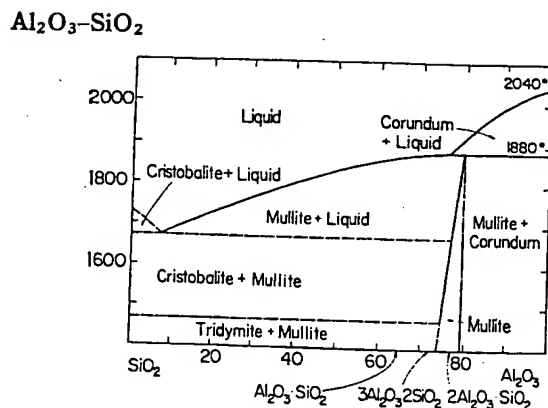


FIG. 313.—System Al<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub>; redetermined.

J. W. Welch, *Nature*, 186 [4724] 546 (1960); also *Trans. Intern. Ceram. Congr., 7th London*, 1960, 1961, pp. 197-206. See also: G. Trömel, K.-H. Obst, K. Konopicky, H. Bauer, and I. Patzak, *Ber. deut. keram. Ges.*, 34 [12] 401 (1957); E. C. Shears and W. A. Archibald, *Iron & Steel*, 27 [26] 61 (1954); N. L. Bowen and J. W. Greig, *J. Am. Ceram. Soc.*, 7 [4] 242 (1924).

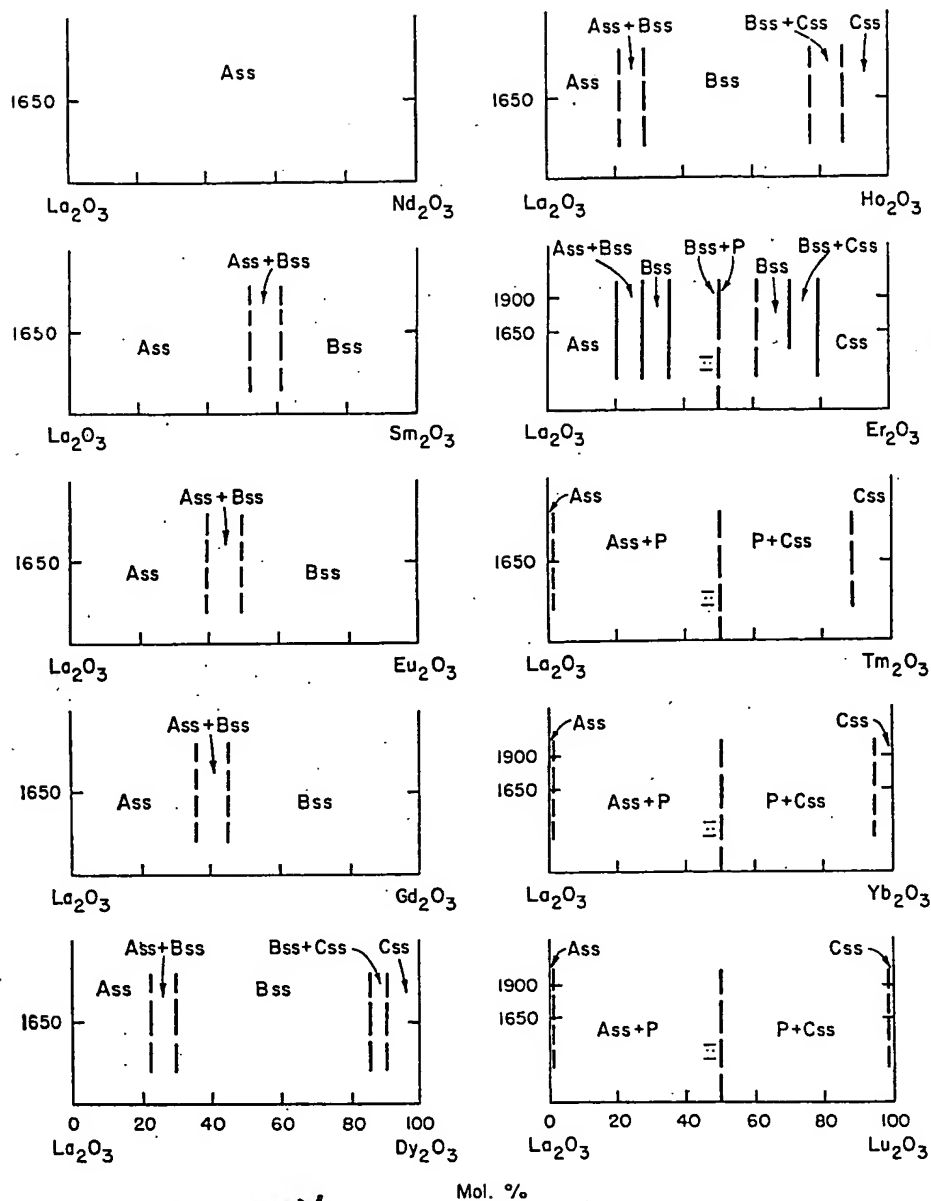
 $\text{La}_2\text{O}_3\text{-Ln}_2\text{O}_3$ 

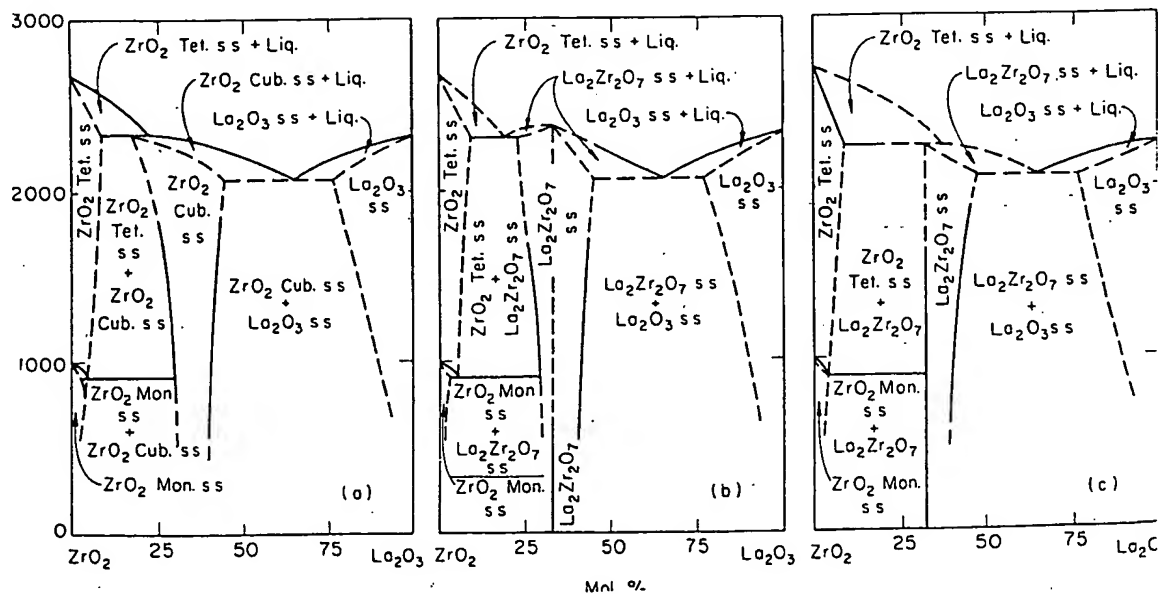
FIG. 345.—System  $\text{La}_2\text{O}_3\text{-Ln}_2\text{O}_3$ ; predicted subsolidus. A, B, C refer to rare earth oxide structure types; P, perovskite.

S. J. Schneider and R. S. Roth, *J. Research Natl. Bur. Standards*, 64A [4] 325 (1960).

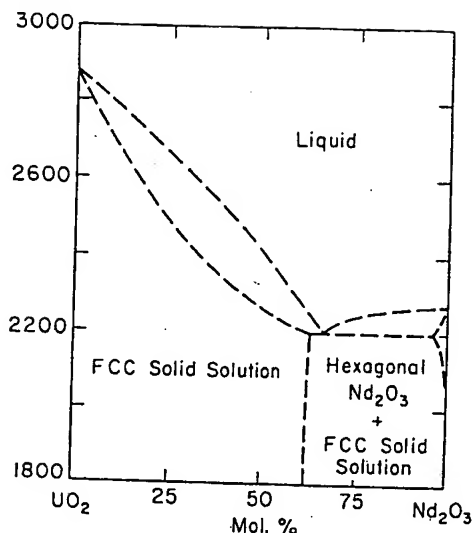
 $\text{La}_2\text{O}_3\text{-ZrO}_2$ 

FIG. 346.—System  $\text{La}_2\text{O}_3\text{-ZrO}_2$ ; possible.

R. S. Roth, *J. Research Natl. Bur. Standards*, 56 [1] 23 (1956); RP2642 (a) After F. H. Brown, Jr., and F. Duwez, *J. Am. Ceram. Soc.*, 38 [3] 9 (1955); (b) showing  $\text{La}_2\text{Zr}_2\text{O}_7$  meltin congruently with solid solution on bot sides; (c) showing  $\text{La}_2\text{Zr}_2\text{O}_7$  meltin incongruently, with solid solution onl on high  $\text{La}_2\text{O}_3$  side.

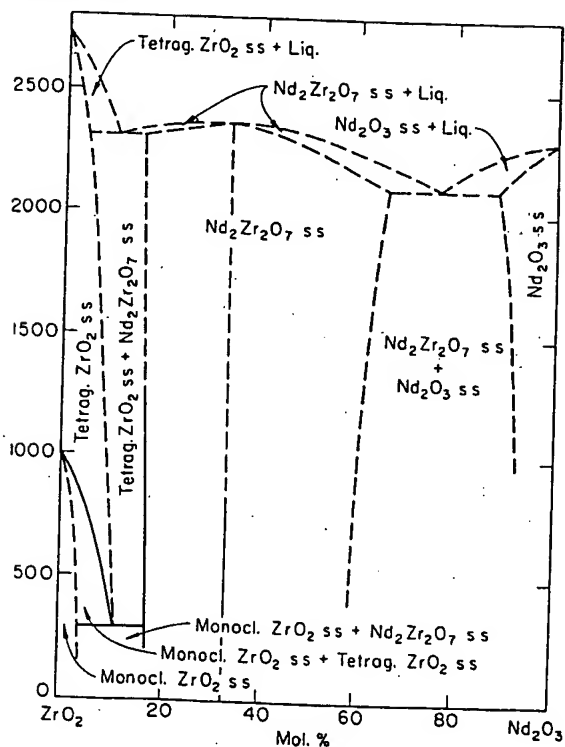


BEST AVAILABLE COPY

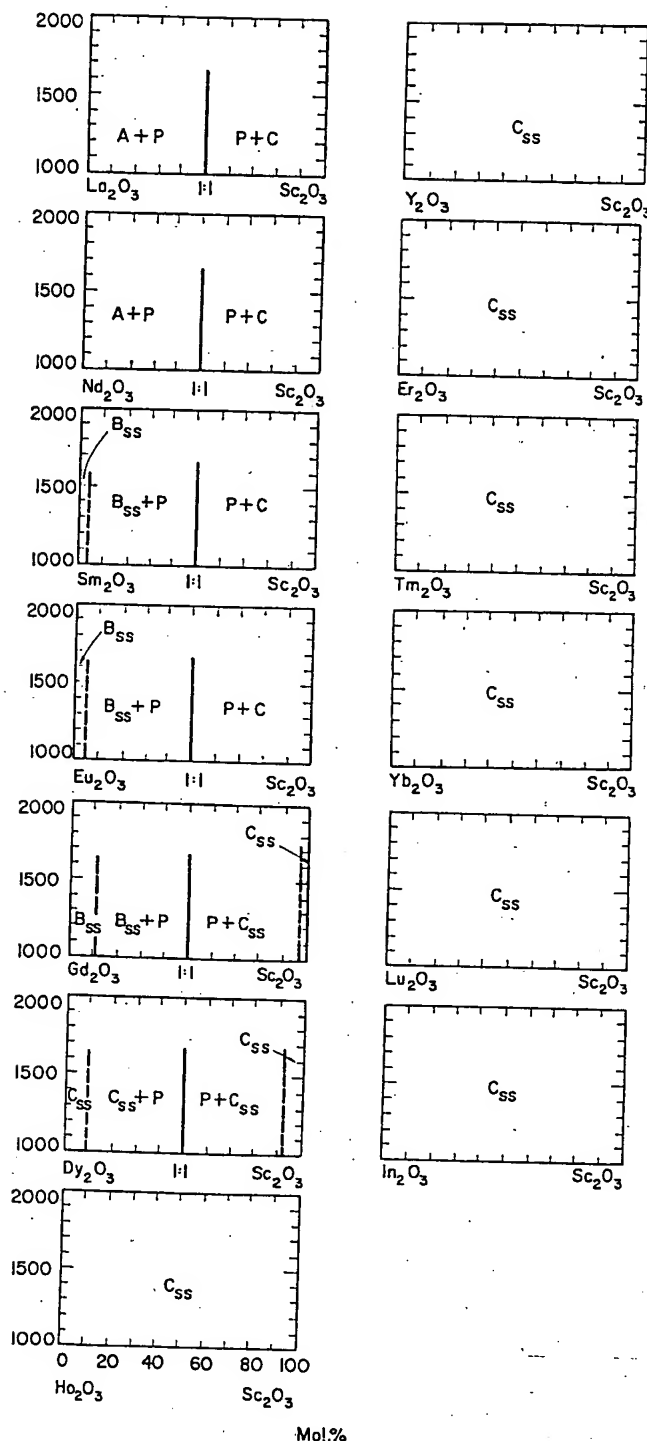
$\text{Nd}_2\text{O}_3\text{-UO}_2$ FIG. 349.—System  $\text{Nd}_2\text{O}_3\text{-UO}_2$ .

S. M. Lang, F. P. Knudsen, C. L. Fillmore, and R. S. Roth, *Natl. Bur. Standards Circ.*, No. 568, p. 16 (Feb. 20, 1956).

After W. A. Lambertson and M. H. Mueller, U. S. AEC unclassified report ANL-5312 (Sept. 14, 1954).

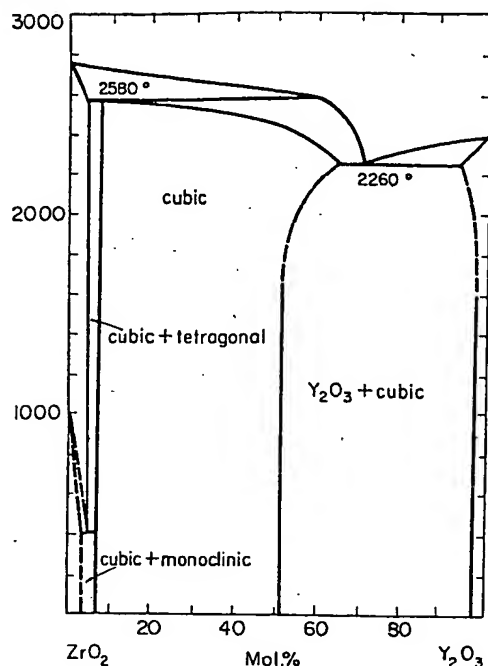
 $\text{Nd}_2\text{O}_3\text{-ZrO}_2$ FIG. 350.—System  $\text{Nd}_2\text{O}_3\text{-ZrO}_2$ ; possible.

Modification showing  $\text{Nd}_2\text{Zr}_2\text{O}_7$  solid solution phase after R. S. Roth, *J. Res. Natl. Bur. Std.*, 56 [1] 24 (1956); RP 2643. Remainder of diagram after F. H. Brown, Jr. and Pol Duwez, *J. Am. Ceram. Soc.*, 38 [3] 95 (1955).

 $\text{Sc}_2\text{O}_3\text{-R}_2\text{O}_3$ FIG. 351.—System  $\text{Sc}_2\text{O}_3\text{-R}_2\text{O}_3$ ; predicted subsolidus. Structure types: A, A-type rare earth oxide; B, B-type rare earth oxide; C, C-type rare earth oxide; P, perovskite.

S. J. Schneider, R. S. Roth, and J. L. Waring, *J. Research Natl. Bur. Standards*, 65A [4] 370 (1961).

BEST AVAILABLE COPY

$Y_2O_3-ZrO_2$ FIG. 354.—System  $Y_2O_3-ZrO_2$ .

H. E. Otto, private communication Dec. 27, 1961. See also, P. S. Duwez, F. H. Brown, Jr., and F. Odell, *J. Electrochem. Soc.*, 98, 360 (1951).

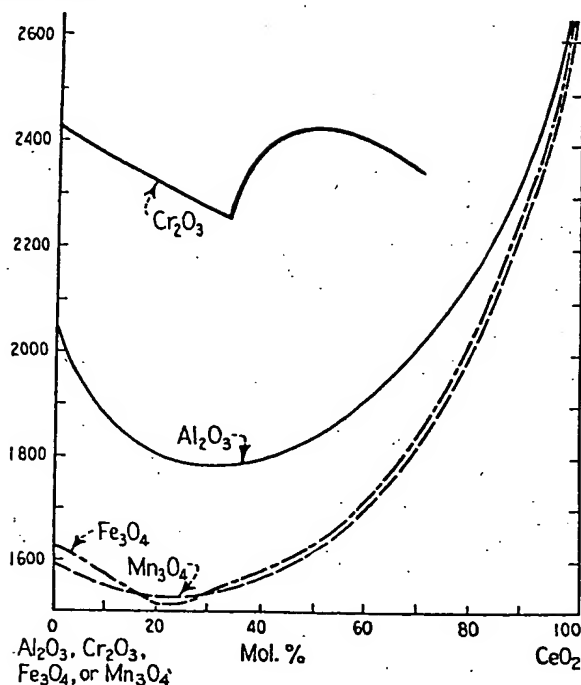
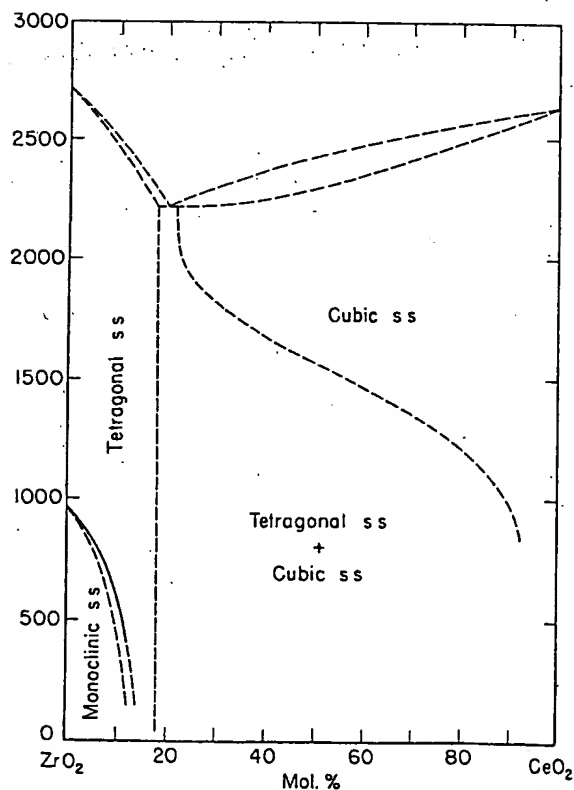
 $CeO_2-R_2O_3, R_3O_4$ 

FIG. 356.—Liquidus curves of systems  $CeO_2-Al_2O_3$ ,  $CeO_2-Cr_2O_3$ ,  $CeO_2-Fe_3O_4$ ,  $CeO_2-Mn_3O_4$ .  
H. von Wartenberg and K. Eckhardt, Part VIII, *Z anorg. u. allgem. Chem.*, 232, 184 (1937)

 $CeO_2-ZrO_2$ FIG. 355.—System  $CeO_2-ZrO_2$ .

Pol Duwez and Francis Odell, *J. Am. Ceram. Soc.*, 33 [9] 280 (1950).

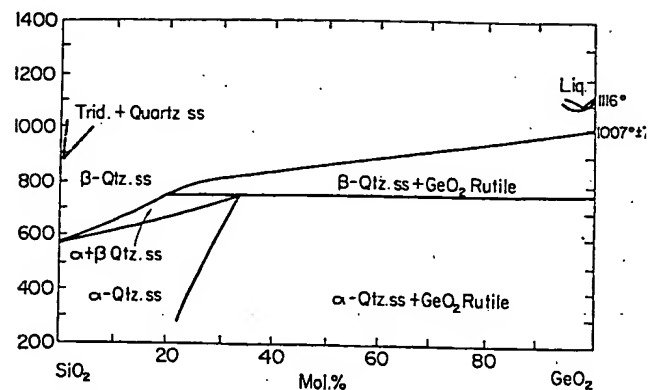
 $GeO_2-SiO_2$ 

FIG. 357.—System  $GeO_2-SiO_2$ . Qtz. = quartz; Trid. = tridymite.

E. C. Shafer and Rustum Roy, *U. S. Army Signal Corps Contract DA 36-039, SC 63099* (1956).

BEST AVAILABLE COPY

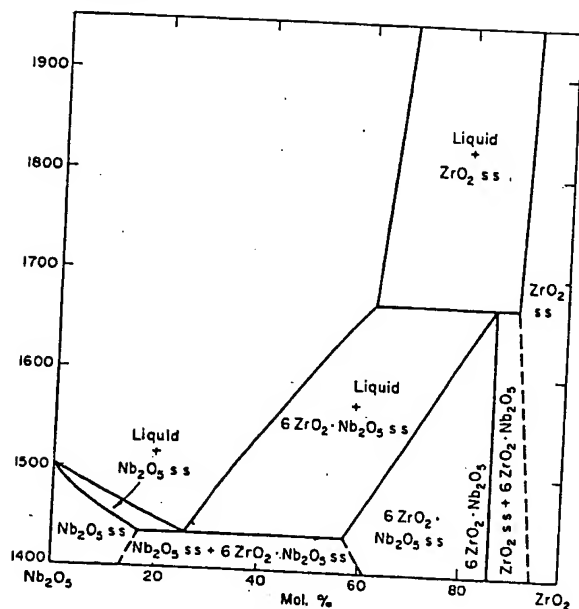
$\text{ZrO}_2\text{-Nb}_2\text{O}_5$ 

FIG. 373.—System  $\text{ZrO}_2\text{-Nb}_2\text{O}_5$ . ss = solid solution.  
R. S. Roth and L. W. Coughanour, *J. Research, Natl. Bur. Standards*, 55 [4] 212 (1955); RP2621.

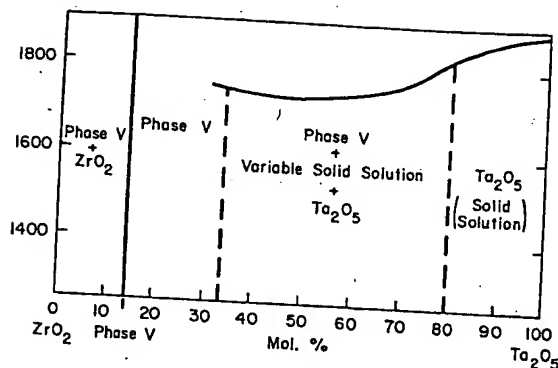
 $\text{ZrO}_2\text{-Ta}_2\text{O}_5$ 

FIG. 374.—System  $\text{Ta}_2\text{O}_5\text{-ZrO}_2$ .

B. W. King, John Schultz, E. A. Durbin, and W. H. Duckworth, U. S. Atomic Energy Comm., BMI-1106, 15 (1956).

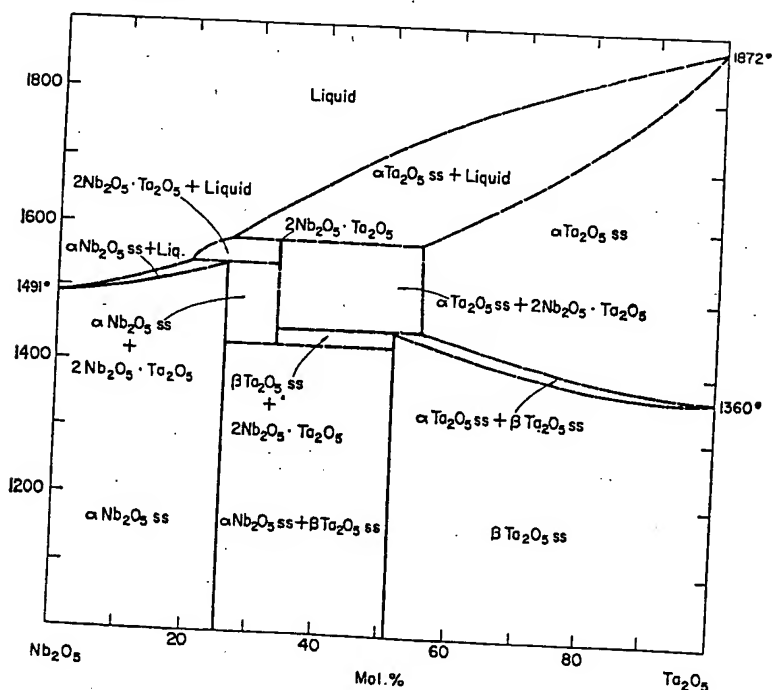
 $\text{Nb}_2\text{O}_5\text{-Ta}_2\text{O}_5$ 

FIG. 375.—System  $\text{Nb}_2\text{O}_5\text{-Ta}_2\text{O}_5$ .

F. Holtzberg and A. Reisman, *J. Phys. Chem.*, 65, 1193 (1961).

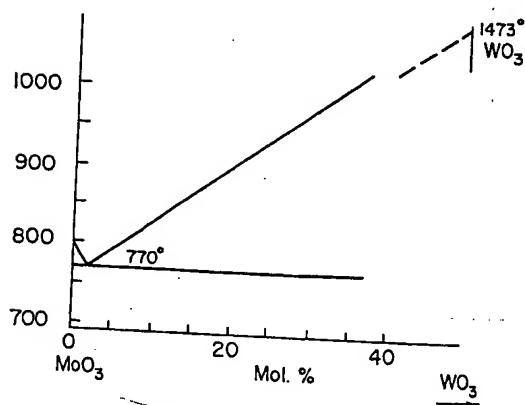
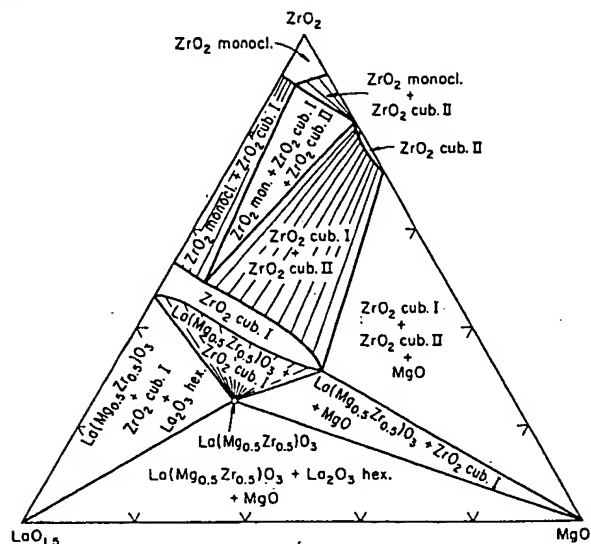
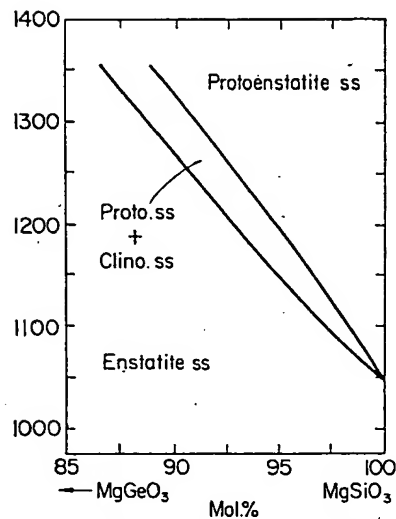
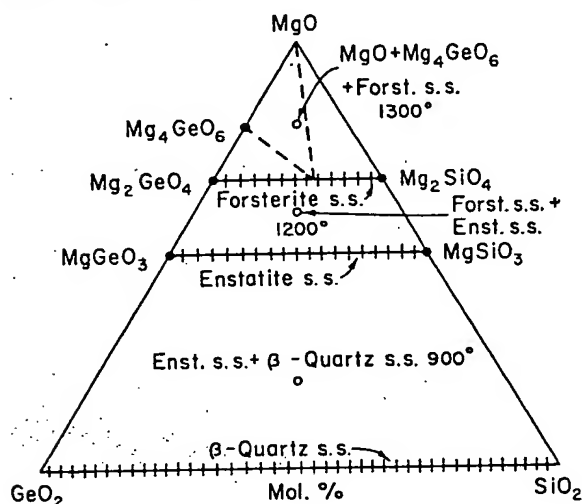
 $\text{MoO}_3\text{-WO}_3$ 

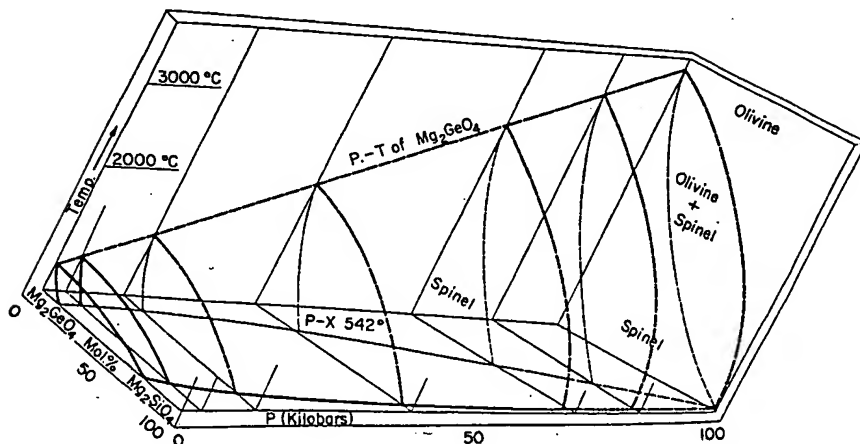
FIG. 376.—System  $\text{MoO}_3\text{-WO}_3$ .  
G. D. Rieck, *Rec. Trav. Chim.*, 62, 429 (1943)

MgO-La<sub>2</sub>O<sub>3</sub>-ZrO<sub>2</sub>FIG. 716.—System MgO-La<sub>2</sub>O<sub>3</sub>-ZrO<sub>2</sub>; at approx. 1400°C.Albrecht Rabenau, *Z. anorg. u. allgem. Chem.*, 288, 224 (1956).FIG. 718.—System MgGeO<sub>3</sub>-MgSiO<sub>3</sub>; partial subsolidus. Clino. = clinoenstatite; Proto. = protoenstatite.

J. F. Sarver and F. A. Hummel, personal communication, Nov., 1961.

MgO-GeO<sub>2</sub>-SiO<sub>2</sub>FIG. 717.—System MgO-GeO<sub>2</sub>-SiO<sub>2</sub>; partial subsolidus. Solid solutions indicated by hatched lines.

J. F. Sarver and F. A. Hummel, personal communication, Nov., 1961.

FIG. 719.—System Mg<sub>2</sub>GeO<sub>4</sub>-Mg<sub>2</sub>SiO<sub>4</sub>; pressure-temperature-composition perspective. Isothermal section at 542°C. (uniaxial pressure) provides basis of construction.Frank Dacheille and Rustum Roy, *Am. J. Sci.*, 258, 236 (1960).

**THIS PAGE BLANK (USPTO)**